MAT-91-12

An Evaluation of the Effectiveness of Swareflex™ Deer Reflectors

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Author(s): J. J. Armstrong - Senior Environmental Researcher, Materials Office

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Contact Person: Jack Armstrong, Materials Office
(416) 235- 5254

Abstract: Swareflex deer warning reflectors were installed to manufacturer's specifications on a section of a two-lane highway in southern Ontario in the summer of 1990. An experimental design, which involved the covering and uncovering of the reflectors on alternate weeks over one year, allowed a comparison of the numbers of deer killed in two time periods. The results showed no significant difference in the numbers of deer killed in these periods. Approximately 50% percent of the deer were killed during the day.

Observations made on deer behaviour, during the passage of vehicles in the test area when the reflectors were operating, confirmed that deer reacted more to the passage of a vehicle than to the activation of the reflectors by a vehicle's headlights.

It was concluded that, under Ontario conditions, the installation of Swareflex reflectors would not be a cost-effective means to reduce deer/vehicle accidents.

Comments: Swareflex is a registered trade name.

Work on this project is now complete and other means of reducing the numbers of deer/vehicle accidents in Ontario are under consideration.

Key Words: Swareflex™, deer warning reflectors, deer/vehicle accidents, reflectors, deer behaviour, highways

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J. J. Armstrong
Senior Environmental Researcher
Research and Development Branch

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For additional copies, contact:
The Editor, Technical Publications
Room 320, Central Building
1201 Wilson Avenue
Downsview, Ontario
Canada M3M 1J8

Telephone: (416) 235-3480
Fax: (416) 235-4872

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1/ Introduction

Every year in Ontario, approximately 1500 deer/vehicle collisions occur, resulting in over $2 million in damage and approximately 200 personal injuries (MTO, 1987).

The standard approach used by transportation departments, including the Ministry of Transportation of Ontario (MTO), to control deer/vehicle accidents has been the placement of two sizes of "leaping deer" signs along both sides of the highway (Figures 1, 2). An alternative is the installation of reflectors claimed to modify deer's behaviour in the presence of traffic. This study tested Swareflex, the reflector manufactured by D. Swarovski and Co., Austria and distributed in North America by Strieter Corp. of Rock Island, Illinois, USA. The distributor and the manufacturer claim outstanding results in Europe and North America.

Several studies have been conducted in North America. Schafer *et al.* (1984) reported that Swareflex reflectors were ineffective in the State of Washington after testing them using an experimental design very similar to that used in this study. Mah (1989) reported that, in Alberta, the reflectors were effective in detering deer from crossing the road at night. Mah also noted that deer appeared to change their movement patterns after the Swareflex reflectors' installation, but this behaviour merely transferred the problem to elsewhere on the highway system. Studies by Gilbert (1982), however, showed that there was no evidence supporting the claim that mirrors effectively reduced deer/vehicle accidents in Maine. Likewise, recent reports by Hester (1991), in Ontario, and Waring *et al.* (1991), in Illinois, concluded that Swareflex reflectors were ineffective in keeping deer off the road when vehicles were present and thus in reducing deer/vehicle accidents.

The result of a 1987 MTO survey of 114 highway departments in Canada and the USA, was that under scientifically-controlled conditions, certain types of reflectors significantly reduced animal/vehicle collisions. This study also reported that the effectiveness of these reflectors was dependent on individual site conditions and traffic/road characteristics (MTO, 1987).

Swareflex deer warning reflectors operate on the basis that deer perceive a red light as a danger signal and thus a series of red reflected lights act as an "optical fence" inhibiting movement. Zacks (1985), however, found no evidence that white-tailed deer have an innate fear of red and concluded that the reflector barrier produced no observable effect. Waring *et al.* (opus cit.), concluded, after observing deer behaviour toward Swareflex reflectors in the presence of vehicles, that behaviour remained unchanged after the reflectors were installed.

Figure 1/ Example of Ministry leaping deer sign

Figure 2/ Swareflex reflector mounted beside Highway 21

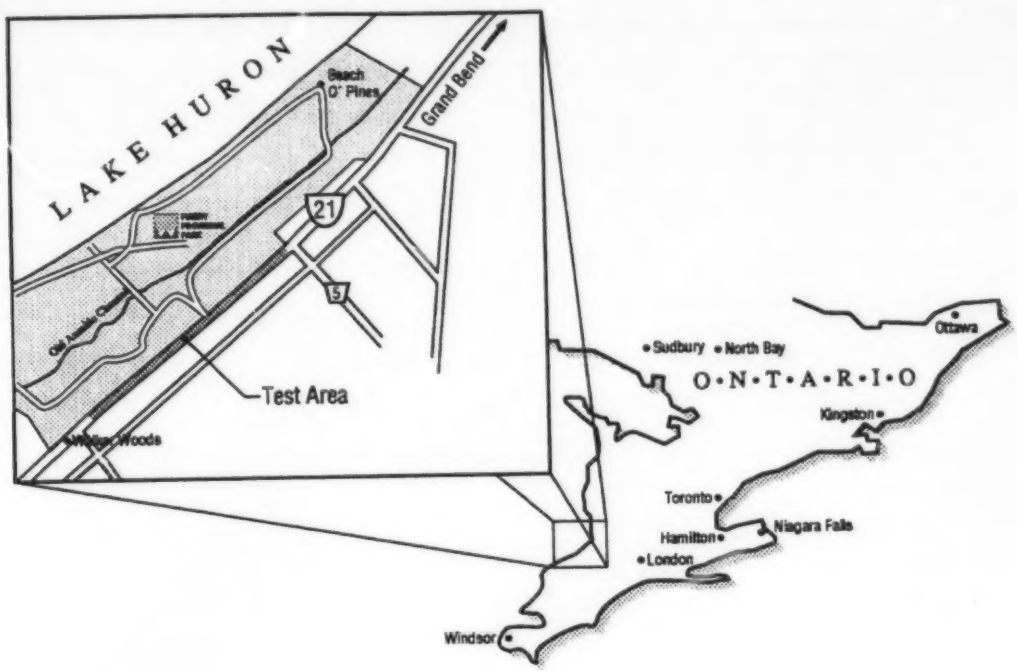

Figure 3/ Location of Swareflex test site

Various techniques have been used to test the effectiveness of deer warning reflectors. Some have involved covering and uncovering the reflectors at set intervals during which the number of deer/vehicle accidents were determined from accident statistics. This is the most amenable approach to statistical testing.

Most studies have compared the numbers of deer/vehicle accidents from year to year. However, since many factors affect deer/vehicle accidents each year, this approach is severely limited.

One of the areas of concentrated deer/vehicle accidents is a 12 km stretch of King's Highway 21 from Grand Bend south to the Ausauble River (Figure 3). Between 1983 and 1989, 229 deer/vehicle accidents were recorded with 64% of these accidents occurring within a 4.1 km section of highway. According to the local Conservation Officer for the Ministry of Natural Resources, many deer/vehicle accidents are never reported so the actual numbers are much higher. Estimates by the Ministry of Natural Resources of the wintering deer population in this area, vary from 450 to 800 animals (Evans, pers. conversation, 1990).

In an effort to reduce the number of deer/vehicle accidents on this section of highway, and to determine the feasibility of more extensive use of this control technique, Swareflex reflectors were installed along this 4.1 km stretch of Highway 21 in August, 1990. This report describes the results of the survey between October, 1990 and October, 1991.

2/ Description of the Study Area

The study area is located on King's Highway 21, in the County of Lambton, approximately 10 km south of the town of Grand Bend (Figure 3). At this location, Highway 21 has a straight two lane alignment, both vertically and horizontally, and serves the recreational traffic centering on Grand Bend and Pinery Provincial Park.

The width of the right-of-way is 30 m. Pavement widths are 7.5 m with 3.1 m of shoulder rounding. The treeline is situated 8 to 10 m from the pavement edge.

The study area has few residents and, as a result, the forest grows up to the edge of the right-of-way. The predominant tree species on these sandy well-drained soils are second growth Oaks (Quercus spp) and White Pine (Pinus strobus). To the west, this vegetation extends to the shores of Lake Huron within Pinery Provincial Park, a distance of approximately 3 km. To the east, the forest is narrower, flanked by an extensive agricultural area producing corn, beans, potatoes, onions and celery. Deer regularly cross the highway to access these crops.

In 1990 there was an exceptionally large crop of mast from the three species of oaks in the area. This large acorn crop noticeably affected the feeding behaviour of deer following the middle of September. After this date and well into the winter, deer movements across the highway were considerably reduced (Koolen, pers. conversation, 1990).

3/ Methodology

Swareflex reflectors were installed on both sides of Highway 21 in August, 1990. Two configurations were used, both recommended in the Manufacturer's installation instructions for the field conditions existing in the study area. In one configuration, the triangular reflectors were fastened to the 2 m, 10.16 cm square cedar posts 1 m from the ground. The posts were placed 14.5 m apart at the edge of rounding on

both shoulders or approximately 3.1 m from the edge of the pavement. This configuration was installed over a distance of 3 km. The other configuration involved the placement of the reflectors at a spacing of 25 m with a distance between reflector lines of 23.5 m so that the reflectors were situated in the ditchline 8 m from the edge of the pavement. This configuration was installed over a distance of 1.1 km. A total of 596 reflectors were installed.

In both configurations, the apex of the triangular reflectors was placed so that the two reflecting surfaces were directed towards the road. Thus, the lights of an approaching vehicle would strike the reflector, be reflected across the road and appear to travel in the same direction as the vehicle. Light from the same vehicle, striking reflectors placed on the opposite side of the road, would tend to behave in the same manner. The alleged effect is to delay or even suppress the deer's passage onto the highway.

Commencing October 12, 1990, the reflectors were covered on alternate Fridays with woven plastic bags. This schedule was maintained with one exception, for a three day period in February a snow storm made it unsafe to follow the schedule.

The local detachment of the Ontario Provincial Police recorded all deer/vehicle accidents that were required to be reported under Provincial Law (damages greater than $700) as well as any others brought to their attention. Only data meeting the following three criteria were used in the analysis:

1. The date of the deer/vehicle accident.

2. The time of the deer/vehicle accident was between one-half hour before sunrise and one-half hour after sunset.

3. The location of the deer/vehicle accident was within the study area.

A simple Chi-square test was used to test for significance (Snedecor, 1956).

Observations of such parameters were made on the brightness of the reflected light, the duration of the flash, and the numbers of flashes. To document the appearance of the reflectors from a perspective different than from the highway, these observations of both configurations of the reflectors were made from the edge of the woodlot, the middle of the ditchline, and the edge of the shoulder.

During the winter, deer behaviour was observed with the assistance of binoculars on clear moonlit nights when snow was on the ground. This combination was almost ideal in permitting observations of deer behaviour toward vehicles and the reflectors. Attempts to make such observations under any other parameters proved unsuccessful.

The practice was to slowly patrol the study area using the car's high beams to illuminate deer along the side of the road. When a deer was spotted, the car was quickly steered to the shoulder and the headlights turned off. The car windows were always kept closed to avoid startling the deer with any unfamiliar sounds. Observations were made with 10 power binoculars through the closed windows, until the deer left the area.

4/ Results

4.1/ Deer/Vehicle Accidents

During the 54 week period between October 19, 1990 and October 31, 1991, 51 deer/vehicle accidents occurred within the study area investigated by the Ontario Provincial Police (Table 1). Of these, 30 occurred during the hours of darkness defined as 1/2 hour before sunrise to 1/2 hour after sunset. Of these 30 deer/vehicle accidents, 14 occurred when the reflectors were uncovered while 16 occurred while the reflectors were covered. The Chi-square Test for Significance showed there was no significant difference between the number of deer/vehicle accidents during the time the reflectors were covered and the number when they were uncovered ($P < 0.75$).

There were 10 nighttime deer/vehicle accidents in the test section using the 14.5 m spacing (Area I) with the reflectors uncovered, compared with 11 when the reflectors were covered. The difference was again not significant ($P > 0.75$). In the 25.0 m test section (Area II), there were 4 deer/vehicle accidents when the reflectors were uncovered, compared to 5 when the reflectors were covered. The difference was again not significant ($P = 0.75$).

Table 1/ Deer/vehicle accident statistics (October 1990 to October 1991)

	Night Time Accidents		Day Time Accidents	
	n	χ^2	n	χ^2
Total Uncovered	14	> 0.13 p < 0.75	9	> 0.05 p < 0.50
Covered	16	> 0.13 p < 0.75	12	> 0.05 p < 0.50
Area I Uncovered	10	> 0.05 p > 0.75	7	> 0.0 p = 1.0
Covered	11	> 0.05 p > 0.75	7	> 0.0 p = 1.0
Area II Uncovered	4	> 0.11 p = 0.75	2	> 1.29 p > 0.25
Covered	5	> 0.11 p = 0.75	5	> 1.29 p > 0.25

During the 54 week period, there were 21 deer/vehicle daytime accidents, 9 when the reflectors were uncovered and 12 when the reflectors were covered. The total daytime deer/vehicle accidents represent 41% of all the deer/vehicle accidents that occurred during the test. There was no significant difference between the numbers of daytime and nighttime accidents ($P > 0.10$).

4.2/ Observations on the Reflectors

Tables 2, 3 and 4 present the results of observations made from various positions on the west side of the right-of-way. The flashes from the reflectors were visible only briefly as vehicles approached. They were not nearly as visible as anticipated when compared to conventional reflectors that delineate such features as the edge of the shoulder, or entrances. The white square reflectors placed on each fifth post, to delineate the edge of the shoulder, were much more visible than the Swareflex reflectors.

Table 2/ Observations made from just inside the forest edge

		Ditch Line Installation	Edge of Shoulder Installation
north moving vehicles	south of observer west side	no effect	no observations made
north moving vehicles	south of observer east side	no effect	no observations made
north moving vehicles	north of observer west side	no effect	no observations made
north moving vehicles	north of observer east side	flashes just in front of vehicle	no observations made
south moving vehicles	south of observer west side	no effect	no observations made
south moving vehicles	south of observer east side	no effect	no observations made
south moving vehicles	north of observer west side	no effect	no observations made
south moving vehicles	north of observer east side	no effect	no observations made

Table 3/ Observations made from ditch line

		Ditch Line Installation	Edge of Shoulder Installation
north moving vehicles	south of observer west side	no effect	no observations made
north moving vehicles	south of observer east side	no effect	no observations made
north moving vehicles	north of observer west side	no effect	no observations made
north moving vehicles	north of observer east side	flashes just in front of vehicle	no observations made
south moving vehicles	south of observer west side	flashes just in front of vehicle	no observations made
south moving vehicles	south of observer east side	flashes occasionally	no observations made
south moving vehicles	north of observer west side	no effect	no observations made
south moving vehicles	north of observer east side	no effect	no observations made

Table 4/ Observations made from edge of shoulder

		Ditch Line Installation	Edge of Shoulder Installation
north moving vehicles	south of observer west side	no effect	no effect
north moving vehicles	south of observer east side	no effect	no effect
north moving vehicles	north of observer west side	momentary flash	momentary flash
north moving vehicles	north of observer east side	momentary flash	momentary flash
south moving vehicles	south of observer west side	momentary flash	flashed occasionally
south moving vehicles	south of observer east side	momentary flash	momentary flash
south moving vehicles	north of observer west side	no effect	no effect
south moving vehicles	north of observer east side	no effect	no effect

4.3/ Observations of Deer Behaviour

These observations were made on February 1, 1991, between 0:00 and 3:00 hours. The reflectors had been uncovered the previous day and were functioning properly. The skies were partly cloudy with a partly obscured moon. Visibility on the ground was fair with reflection from a 3-6" cover of snow. Under these conditions, deer were quite visible with the aid of binoculars. On a number of occasions deer ran away when the car with its lights turned off was pulled onto the shoulder of the highway. The low numbers of vehicles on the road, especially after 2:00 AM, restricted the number of observations of deer behaviour.

4.3.1/ Observation # 1

The deer was observed just inside the roadside edge on the west side of the highway where the reflectors had been installed in the ditchline. The deer was standing, ears fully erect, looking directly

at the car as it passed. In the interval when the car was turned around and returned to the site, the deer had disappeared into the woods.

4.3.2/ Observation # 2

The deer was observed standing at the edge of the woodlot on the west side of the highway just to the north of the Pinery Provincial Park entrance. Here the reflectors were at the edge of the shoulder. This deer looked directly at the car as it passed and then ran into the woods while the car stopped.

4.3.3/ Observation # 3

Two deer were seen in the ditchline on the west side of the highway just opposite the Lambton County Museum, feeding on ground vegetation. As soon as the car was driven onto the shoulder of the highway, they lifted their heads, looked directly at the car and then ran into the woods.

4.3.4/ Observation # 4

As the car approached on the west side of the highway, two deer were observed feeding in the vicinity of Observation # 1. As the car passed, one deer lifted its head and looked directly at it. The other deer did not lift its head. Neither deer made any move to depart. During these observations, the speed of the car remained constant and no attempt was made to move to the shoulder.

The car was then turned around so that it was proceeding on the east side of the highway. Upon approaching the deer, the car was slowed and the lights were turned off as the car was moved to the shoulder of the road on the east side. During this time, two other vehicles passed on the west side of the highway. As the car was slowed, moved on to the shoulder, and the engine turned off, the deer most easily observed, deer # 1, stopped feeding, looked straight at the vehicle and after approximately one minute, resumed feeding. At this point deer # 1 was approximately 10 m from the edge of the pavement and 5 m from an uncovered reflector. Meanwhile, the other deer, deer # 2, was at the edge of the woodlot feeding on ground vegetation and took no notice of the passing cars. When a vehicle passed deer # 1 on the east side of the highway, it made no movement. When a second vehicle passed on the east side, deer # 1 raised its head just as the vehicle passed, left it up for about 5 seconds and then resumed feeding.

When a vehicle passed deer # 1 on the west side of the highway, the deer lifted its head exactly as the vehicle passed, looked directly at it and resumed feeding as soon as it had passed. As two vehicles passed deer # 1 on the east side, it raised its head, looked directly at them, and then resumed feeding.

As another vehicle came on the west side of the highway, deer # 1 continued to feed until a few seconds before the vehicle passed, then the deer raised its head, looked directly at the observer and resumed feeding after the vehicle had passed.

This was the first instance when one might conclude that this deer was reacting to the reflectors, since it ceased feeding and lifted its head seconds before the vehicle passed. It would be during these "seconds" that the reflectors would be fully visible to the deer. Since the deer appeared to look in the direction of the observer, it may have picked up reflections from the east side of the highway.

As another vehicle passed deer # 1 on the east side of the highway, the deer lifted its head while the vehicle was still some distance away, and then resumed feeding. Even as the car continued to approach and the lights and sounds became more noticeable, the deer continued to feed. Approximately four seconds before the vehicle passed, the deer lifted and turned its head to look at the car, and then resumed feeding.

Deer #2, meanwhile, was barely visible just inside the woodlot. No movements by this deer were observed while vehicles were passing.

Before leaving, the observer opened the window and coughed several times to observe the resulting behaviour. Deer #1 lifted its head, looked in the direction of the observer, then resumed feeding. However, when the next vehicle came along, deer # 1 moved into the woodlot as the vehicle passed.

4.3.5/ Observation # 5

One deer was observed on the west side of the highway just to the north of the Pinery Provincial Park entrance. It ran into the woods and started to feed as the car was pulled onto the shoulder of the road and stopped. As a vehicle approached on the east side of the highway, this deer lifted its head about 12 seconds before the vehicle passed and then resumed feeding after the vehicle passed. As another vehicle approached on the west side of the highway, this deer lifted its head as the vehicle approached. When the vehicle passed by, the deer started to walk quite quickly into the woodlot.

4.3.6/ Observations # 6, 7 and 8

In all cases the deer ran into the woods while the car was being manoeuvered onto the shoulder of the highway, so no observations were made.

5/ Conclusions

5.1/ Deer/Vehicle Accidents

The results of the Chi-square analysis showed that the differences between the number of deer/vehicle accidents that occurred when the reflectors were covered (i.e. inoperative) and when they were operative, for both the 14.4 and 25 m configurations, were not statistically significant. The conclusion is that the installation was ineffective in reducing the number of deer/vehicle accidents. However, since the reflectors were installed according to the manufacturer's instructions, and since several papers have reported some degree of deer/vehicle accident reduction, it is difficult to explain these discrepancies.

It is believed that most deer/vehicle accidents occur during the night when deer are more active. The results from the present study suggest an equal chance of a deer/vehicle accident during the day as during the night.

5.2/ Deer/Vehicle Observations

The most significant observation of deer behaviour toward the reflectors was in the degree of deer response to the passage of the vehicle. With few exceptions, the deer lifted its head exactly when the vehicle passed. On only two occasions were observations made that showed the deer acting before the vehicle passed. Waring (1991) made only one observation during 14 months that clearly demonstrated a definite response toward the activated reflectors. Otherwise, Waring noted that deer commonly looked up from feeding with the passage of a vehicle. The expected behaviour, if the reflectors were effective in modifying deer behaviour, would be for a deer to raise its head and look toward a reflector prior to the passage of the vehicle, since the reflectors are activated long before the vehicle passes the deer. The observations predominantly demonstrated that the deer responded when the vehicle was immediately opposite it, and therefore one would conclude that the deer responded to the exponential increase in the sound and light intensity of the approaching vehicles, and that the deer's response to the reflectors was far weaker.

The conclusions on the behaviour of deer towards the reflectors are somewhat limited, since there was no control period in which observations were made on deer behaviour when the reflectors were covered. Such observations would help to explain the two instances when the deer appeared to react to the reflected lights by lifting their heads and looking at an object in front of the approaching vehicle rather than at the vehicle at the exact moment of passage. This behaviour, seen twice by the author, may simply be normal behaviour for a feeding deer.

6/ Acknowledgements

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